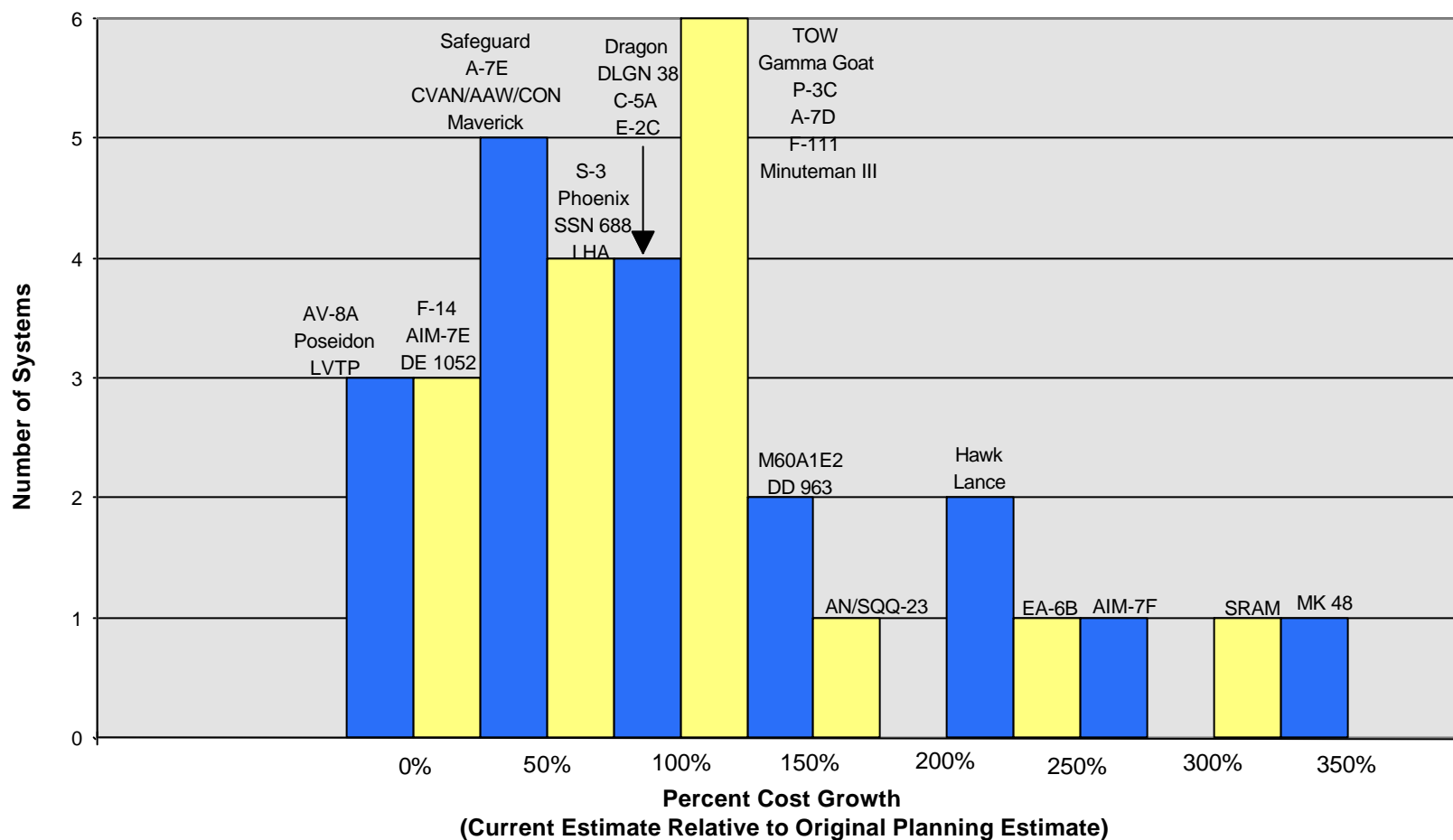
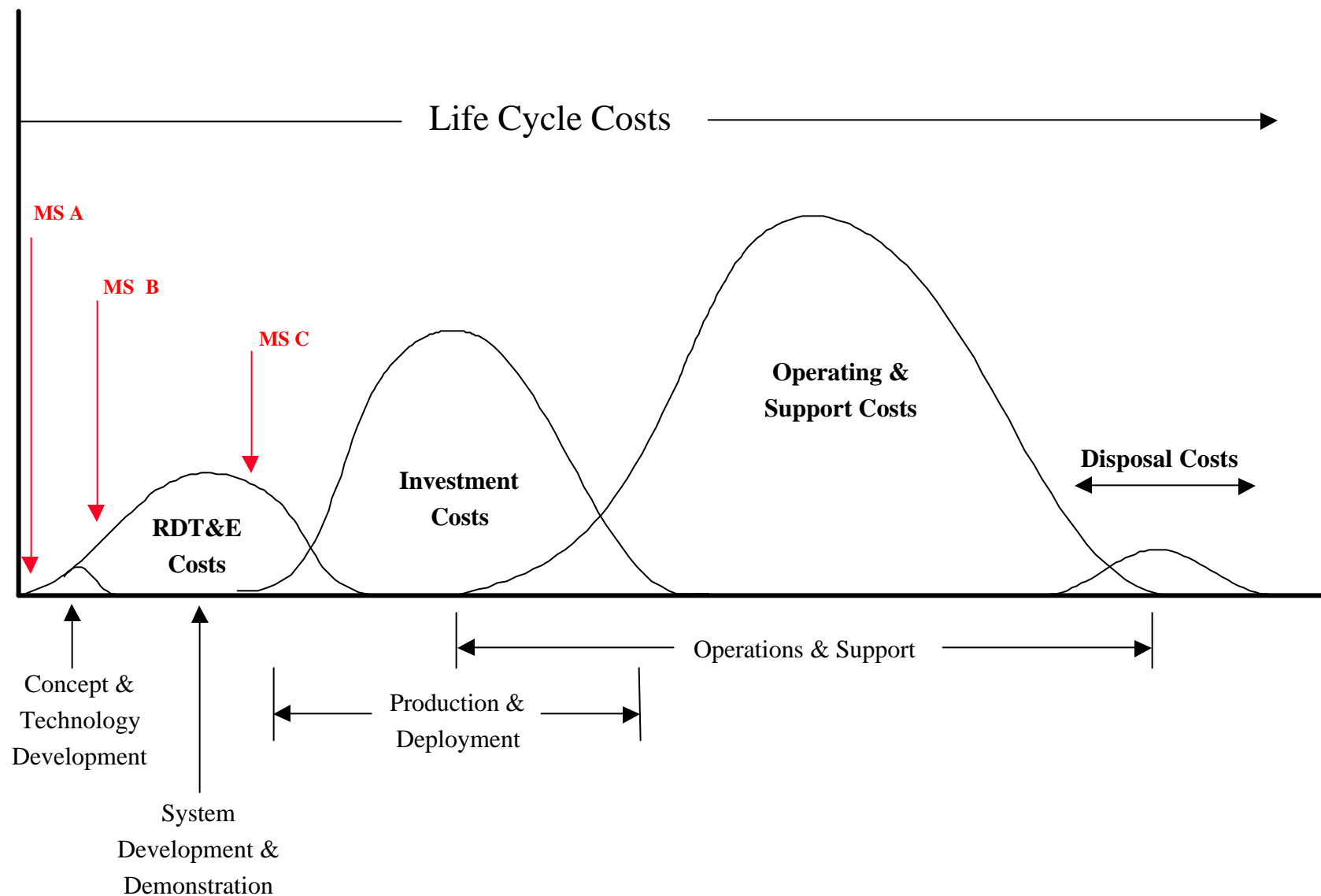


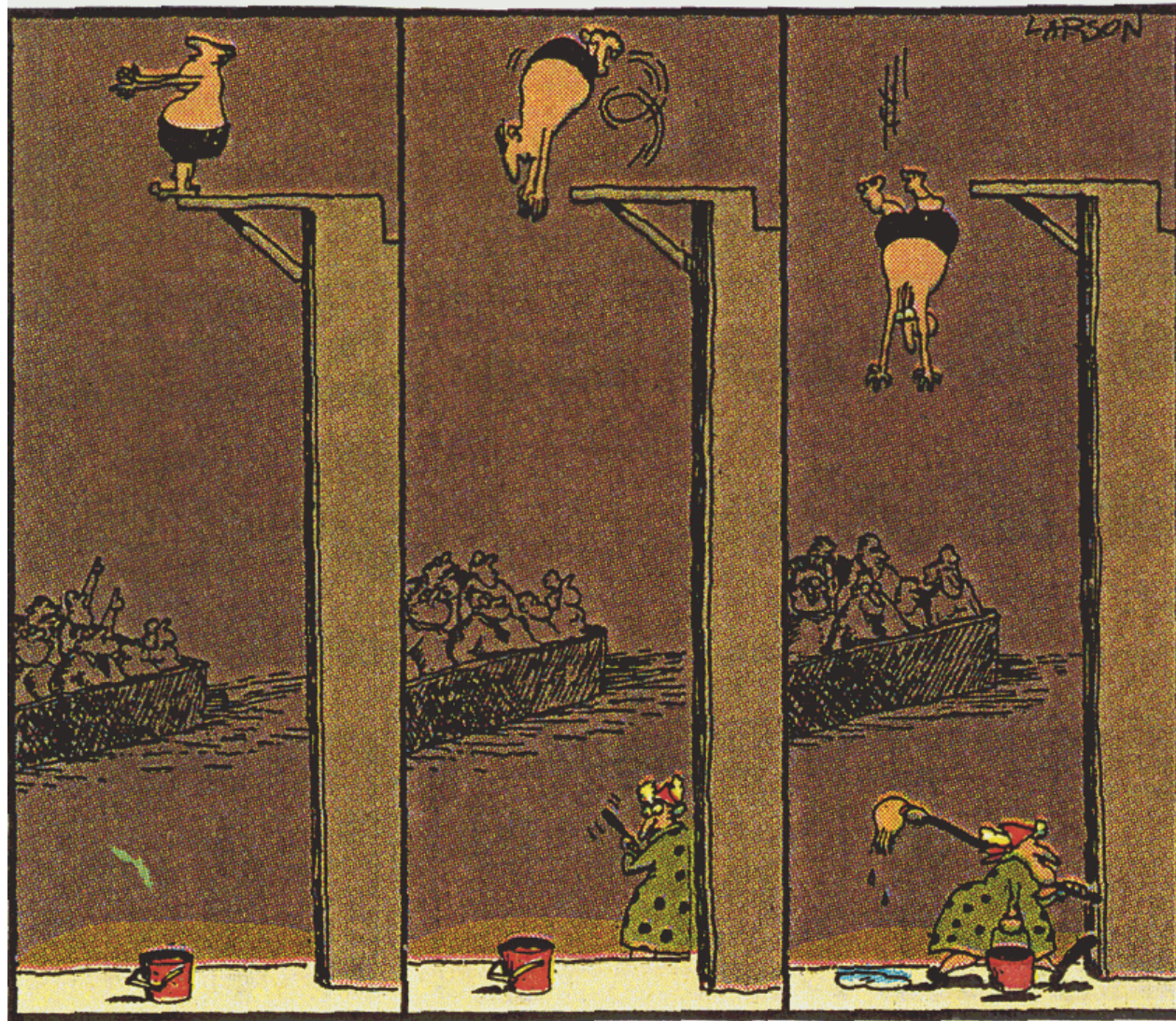
# Cost Growth Mid to Late 1960s



Report Documentation Page		
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<b>Title and Subtitle</b> Cost Growth Mid to Late 1960s	<b>Contract Number</b>	
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<b>Report Classification</b> unclassified	<b>Classification of this page</b> unclassified	
<b>Classification of Abstract</b> unclassified	<b>Limitation of Abstract</b> UU	
<b>Number of Pages</b> 20		



# A Cost Estimator's View of Reality



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# CARD Contents

## System Overview

- **System Description** - mission, key performance parameters, relationship to other systems, picture or diagrams with major parts and subsystems identified.
- **Characteristics** - technical description of hardware and software, discussion should follow the elements in the WBS
- **Quality Factors** - operational availability, reliability, availability and maintainability requirements
- **Reference Systems** - describe currently operational system or/and systems with similar mission, discuss how this system is different.

# Parametric Estimating

- **PROBLEM:** Estimate cost of a new item
- **SOLUTION:** Scale and adjust actual costs for similar items
- **Parameters scale costs to technical content**

Memory

HD Capacity

I/O Speed

Power

Video Memory

Processing Speed

- **Other adjustments account for temporal changes**

Inflation

Technology Advancement

# A Parametric Example

## Beam Steering Assembly of a Radar Seeker

- Data base:
  - AMRAAM (Hughes)
  - AMRAAM (Raytheon)
  - Sparrow-M
  - Phoenix A
  - Longbow
  - MLRS-TGW
  - Phoenix C
  - Patriot
  - Other Systems

- Cost-estimating relationship (first unit production cost)

$$\text{Cost} = 0.007 * \text{Antdia}^{0.46} * \text{Channels}^{0.87} * \text{Axes}^{1.64} * \text{Error term}$$

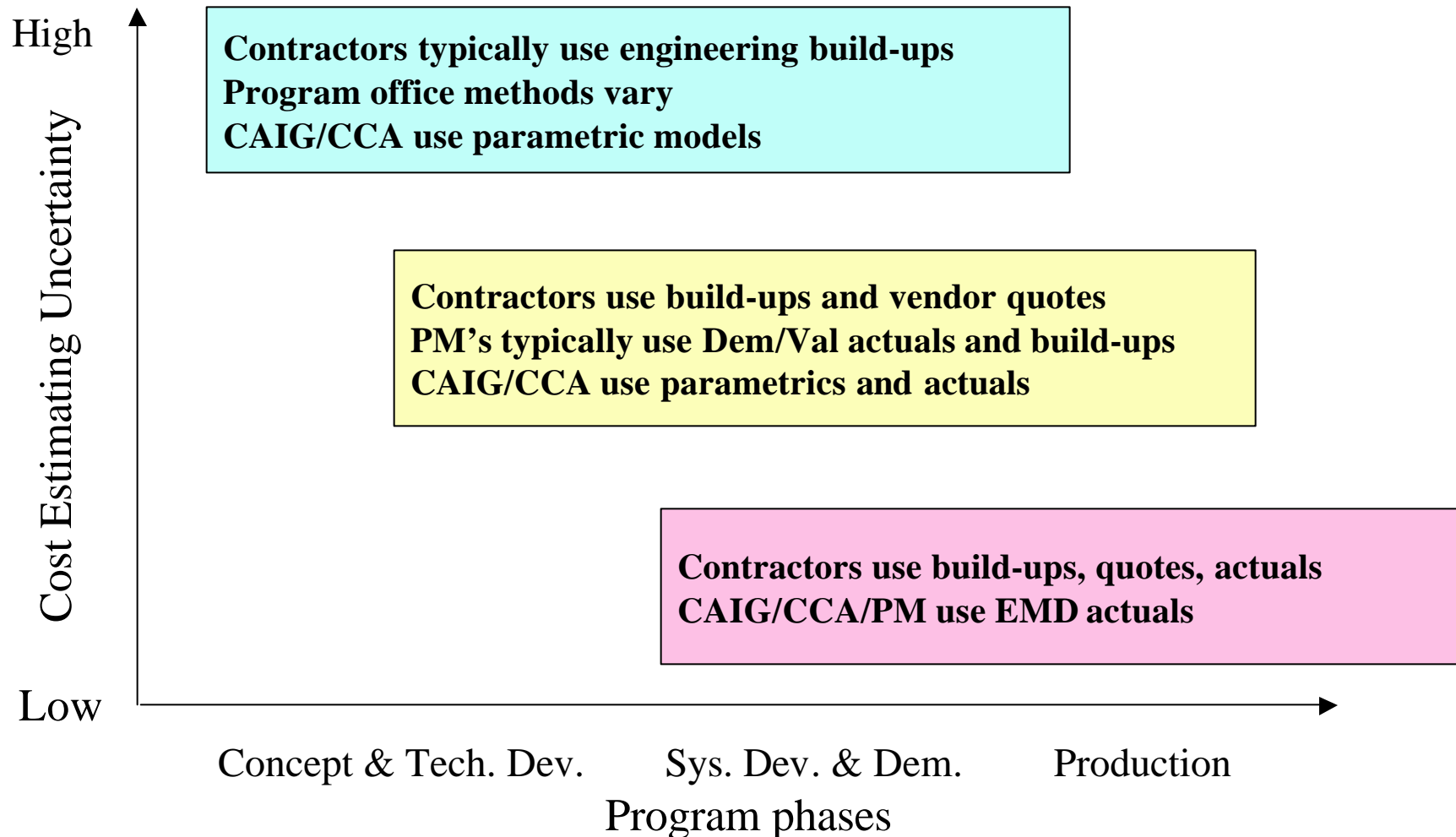
Antdia = Antenna diameter, cm

Channels = Number of RF receive channels

Axes = Number of axes of articulation in gimbal

- Suppose: Antdia=20 cm, Channels= 10, Axes=3
- Then: Cost = 0.361 (FY88 \$M)

# Current Cost Estimating Techniques



# Cost Growth Study

- Data taken from SARs up through Dec 1998
- Study compares final cost to MS II estimate
- Quantity normalized estimate at EMD approval (i.e., MS II) is baseline
- Percent cost growth metric is:  $\left( \frac{CurrentEstimate}{BaselineEstimate} - 1 \right) \times 100\%$
- Study has been publicly discussed, but not yet released

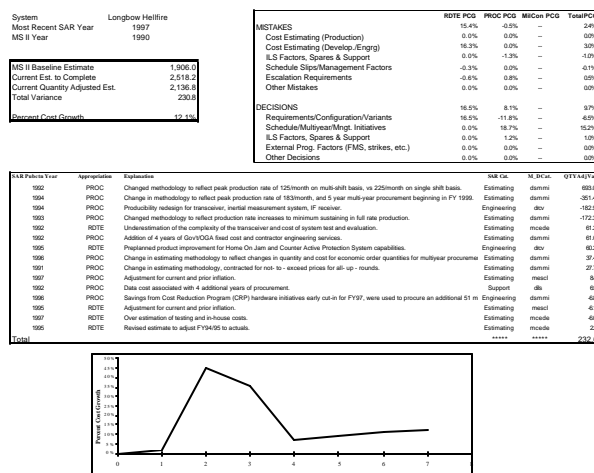
*No other study of comparable scope that employs such detailed data*

## Study Details

# Universe

SARs Currently Useable	143	In Our Sample	131
Excluded	95	Analysis in Process	12
Data Problems (in process)	13	SARs Currently Useable	143
Early EMD	13		
Total	264		

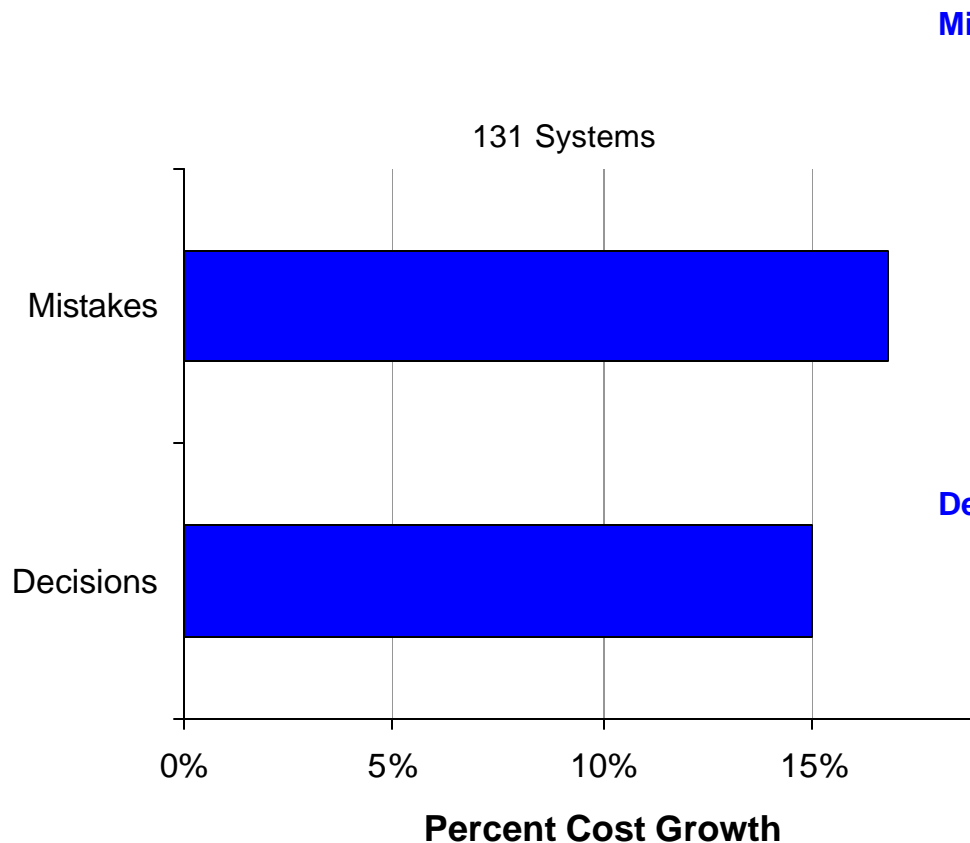
## Sample Data Sheet



## Results

Total Cost Growth Since Milestone II			
	RDT&E	Procurement	Total
Cost Growth			
Arithmetic Average	52%	26%	32%
Dollar Weighted Average	27%	15%	17%
Number of Systems	125	129	131

# Decisions and Mistakes Cost Growth



## Mistakes

- Production assumption and estimation changes
- Engineering, test, and development changes
- ILS changes, and spares and support changes not attributable to post-milestone II discretionary decisions
- Schedule slips attributable to technical problems
- Other changes not attributable to discretionary changes

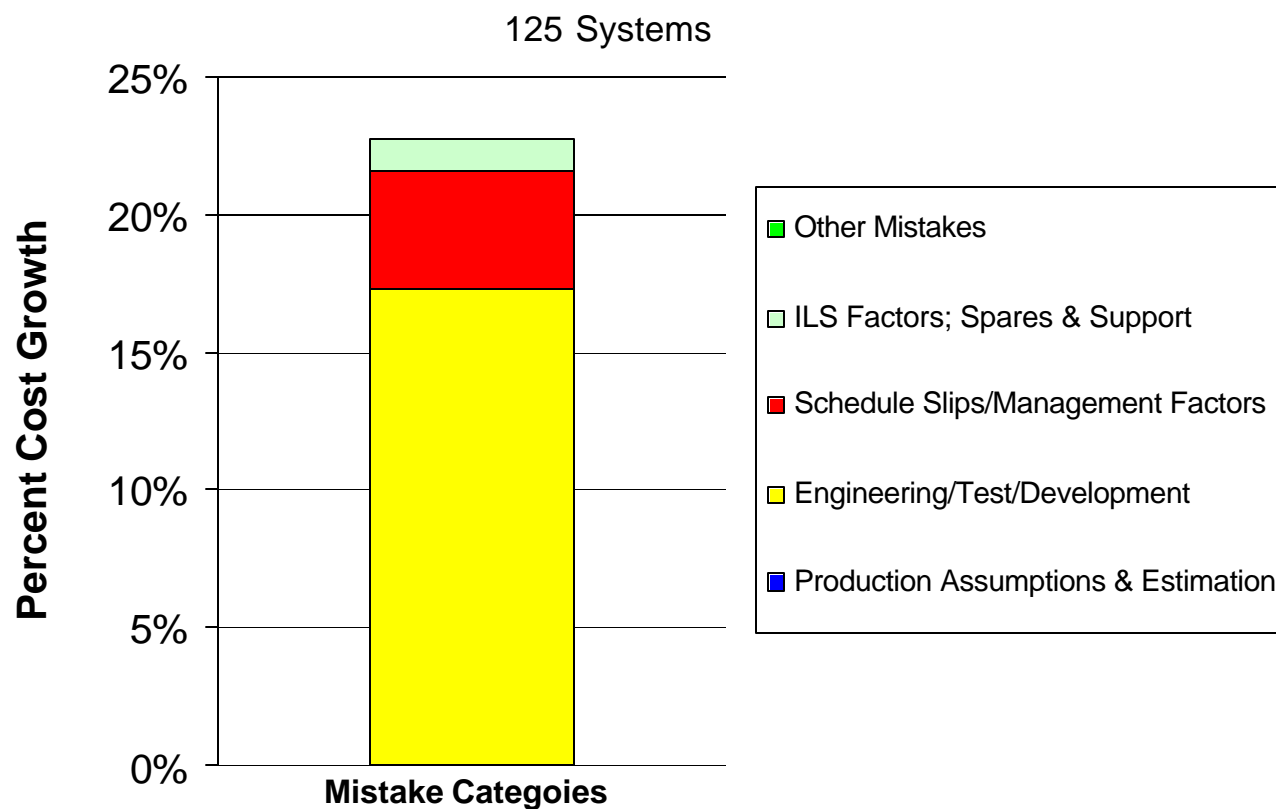
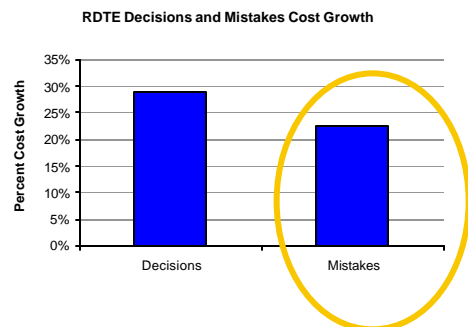
## Decisions

- Requirements, configuration, and variant changes
- Schedule changes, and acquisition strategy changes (e.g., multiyear procurement, dual-sourcing), and management initiatives
- ILS changes, and spares and support changes
- External program factors (FMS, strikes, etc.)
- Other discretionary changes

*Nearly half of perceived cost growth is content change*

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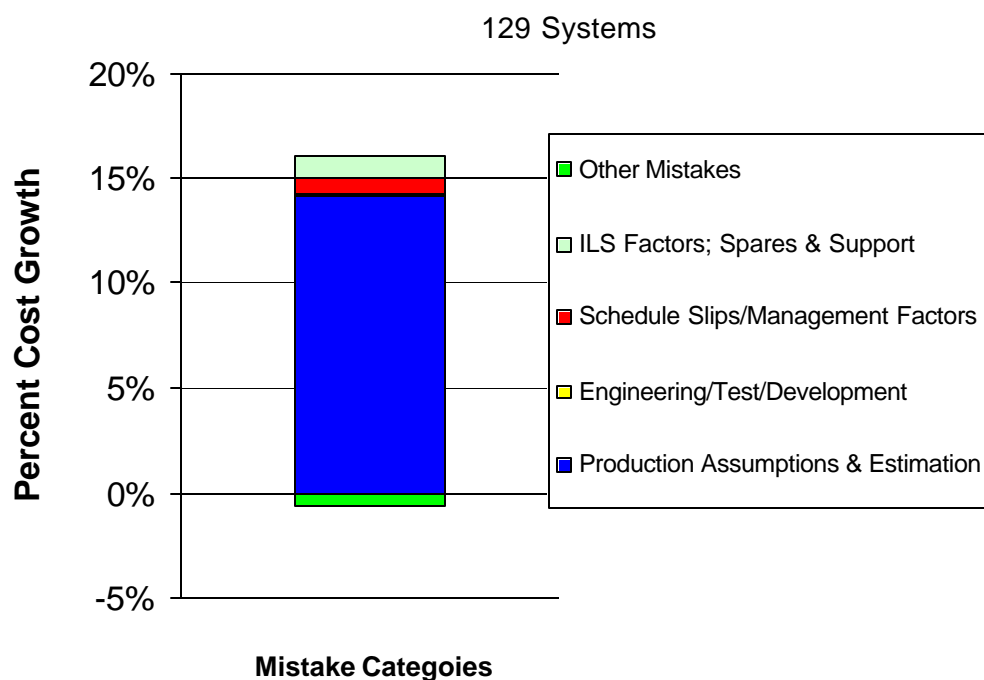
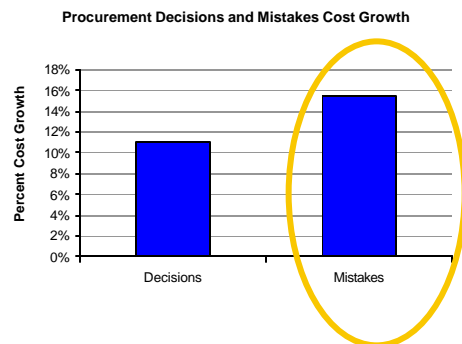
# Mistakes RDT&E Cost Growth



***Underestimated engineering effort major source of error***

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# Mistakes Procurement Cost Growth

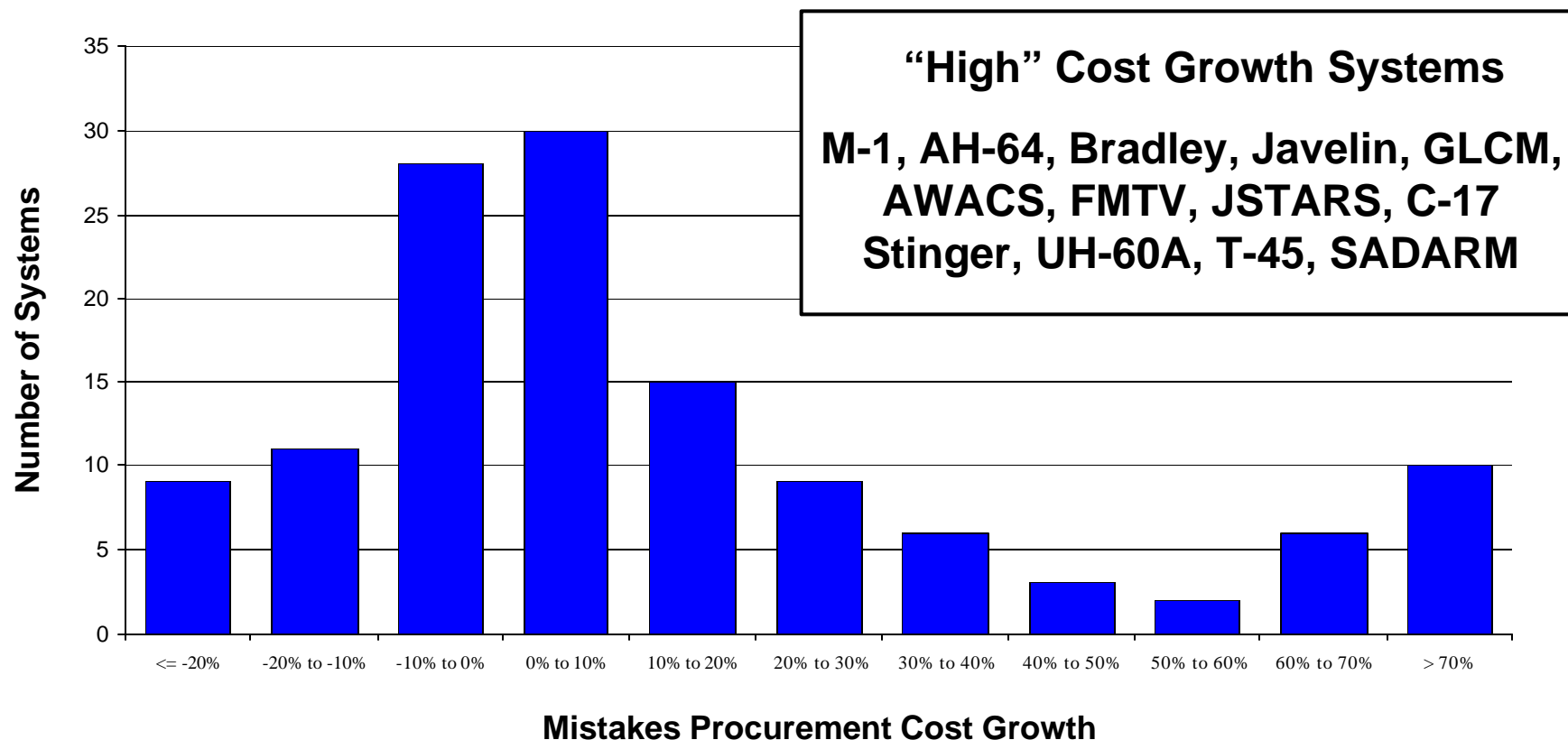


***Major source of error: Too optimistic learning curve slopes***

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# Mistakes Procurement Cost Growth

129 Systems



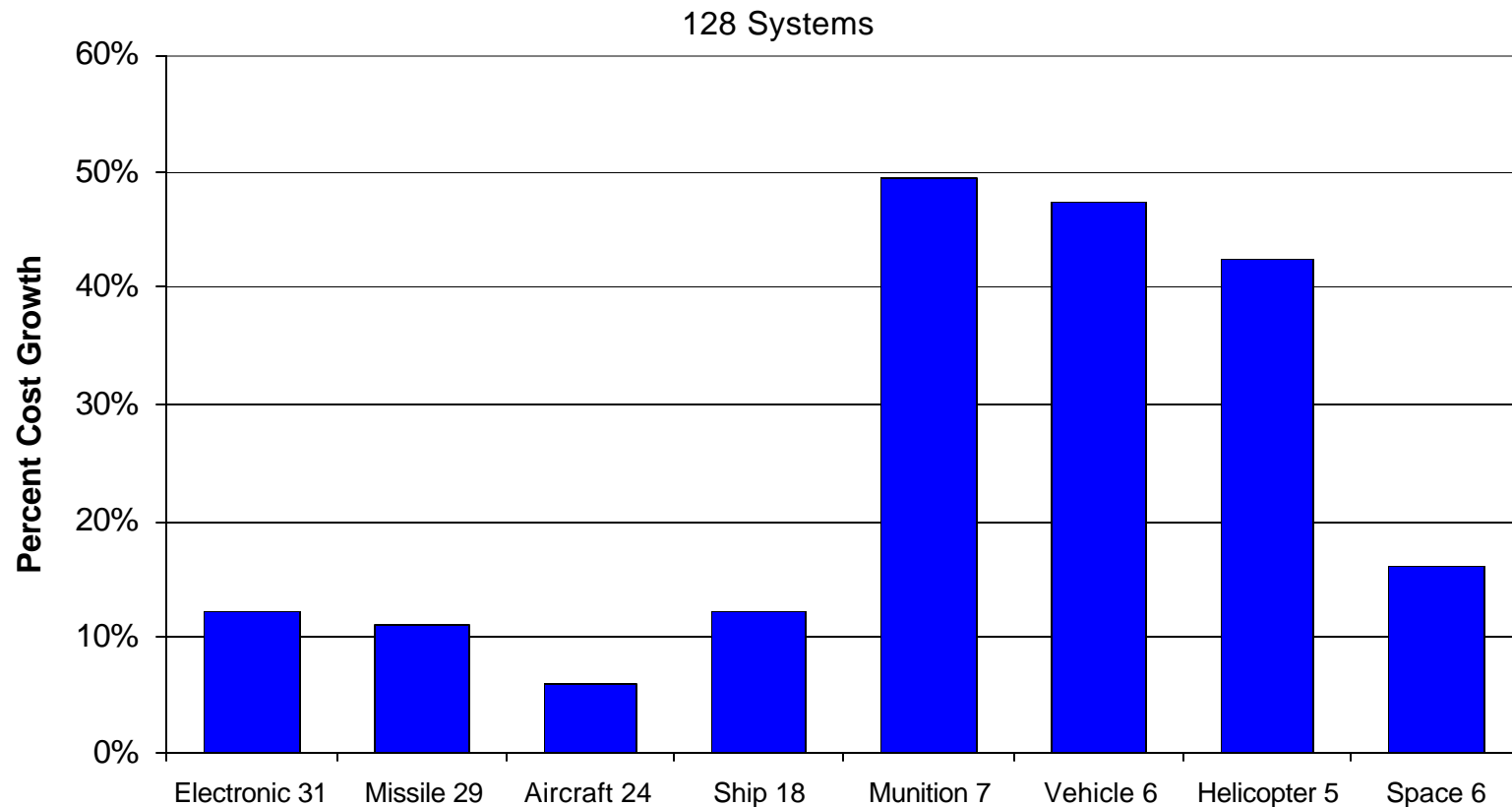
*Problem is “high” cost growth systems, not the average*

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# Hypotheses on Causes of Cost Growth

- **Honest professional error**
  - Poor data
  - Wrong technique
  - Technical assumptions
- **Institutional Imperatives**
  - “Camel’s nose” -- budget strategy
  - “Tension on the reins” -- contractor management
  - Requirement/resources standoff

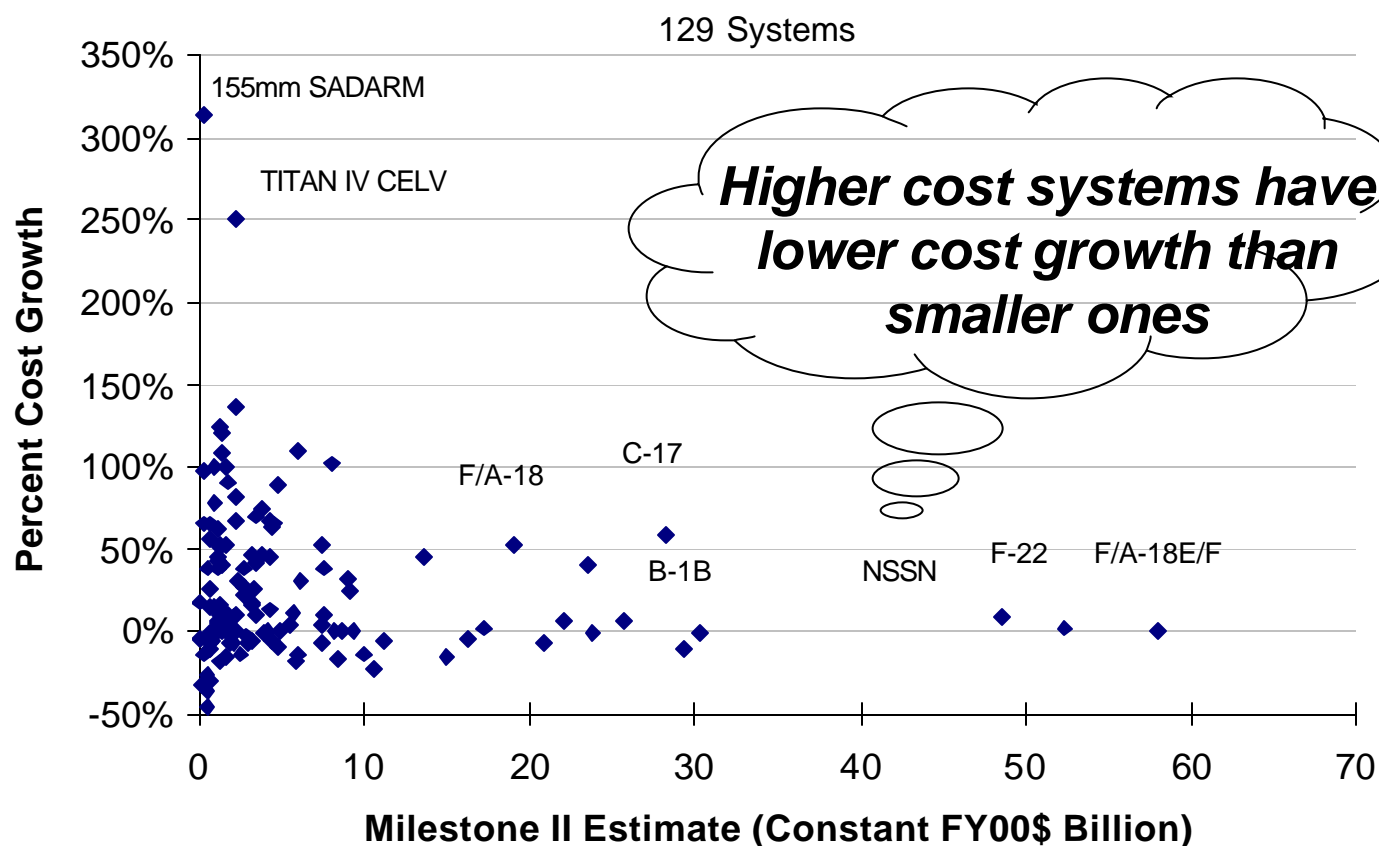
# Mistakes Procurement Cost Growth by Commodity Class



***Commodity classes with fewer systems are more problematic***

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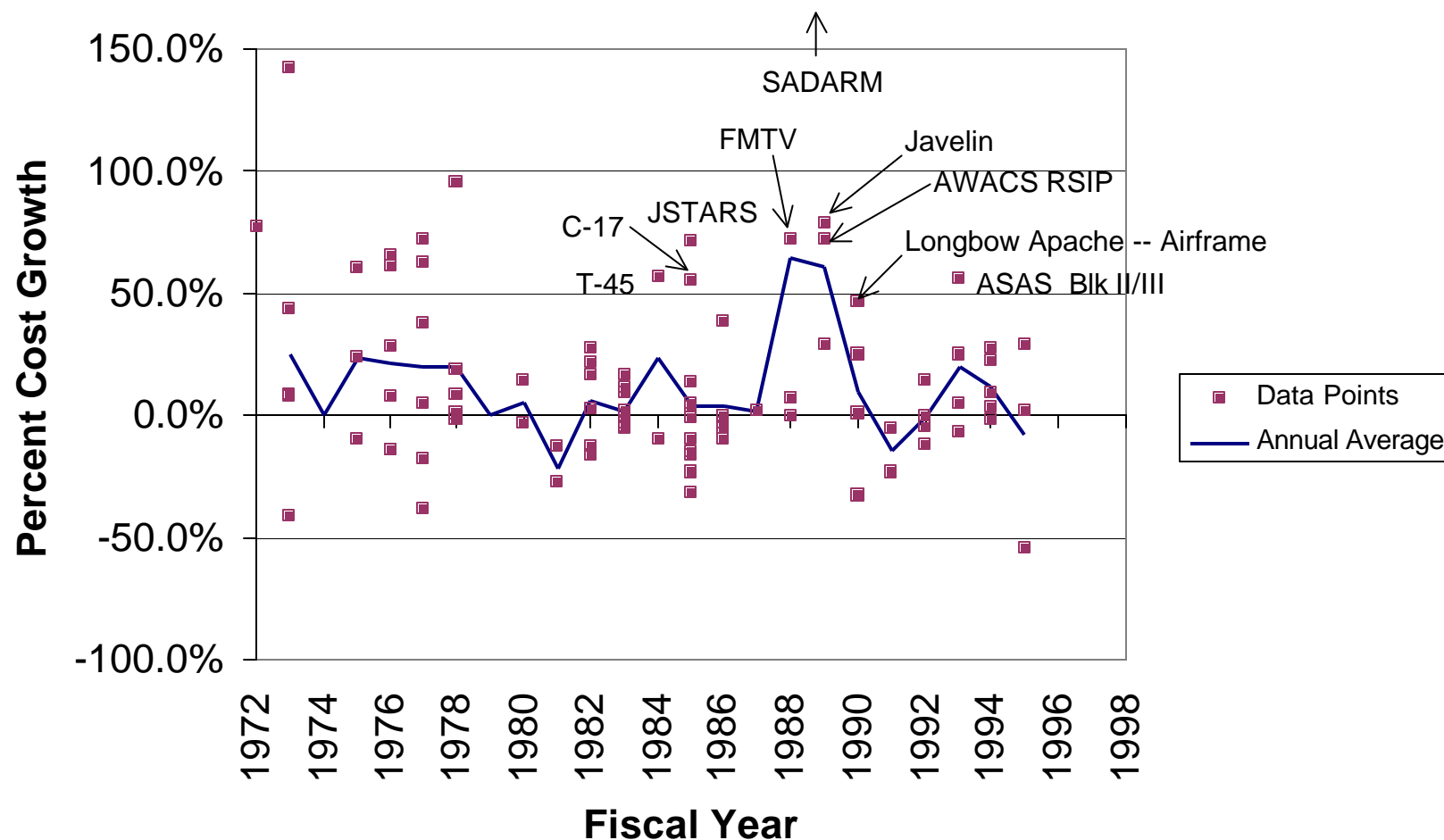
# Procurement Cost Growth by Program Size



*Do services budget to cost for large programs and cost to budget for smaller ones?*

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# Mistakes Procurement Cost Growth for Systems Passing MS II in the Fiscal Year



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# Levers for Improvement

- **Competition/Incentive Contracting**
  - Dual Sourcing
  - Price Commitment Curve (PCC)
- **Acquisition Policy & Budget Policy/Mechanism**
  - Carlucci Initiatives #6 -- Budget to Most Likely Costs
  - POM CAIGs
  - TRACE
  - Fully Fund PM's Estimate
  - Acquisition Stability Fund
  - SCA and M Accounts
  - Impoundment/Termination
- **Independent costing**
  - CAIG creation in 1972
  - IG report increased size in 1992
  - Statute enacted in 1984

# Mistakes Cost Growth in Dual Source Programs

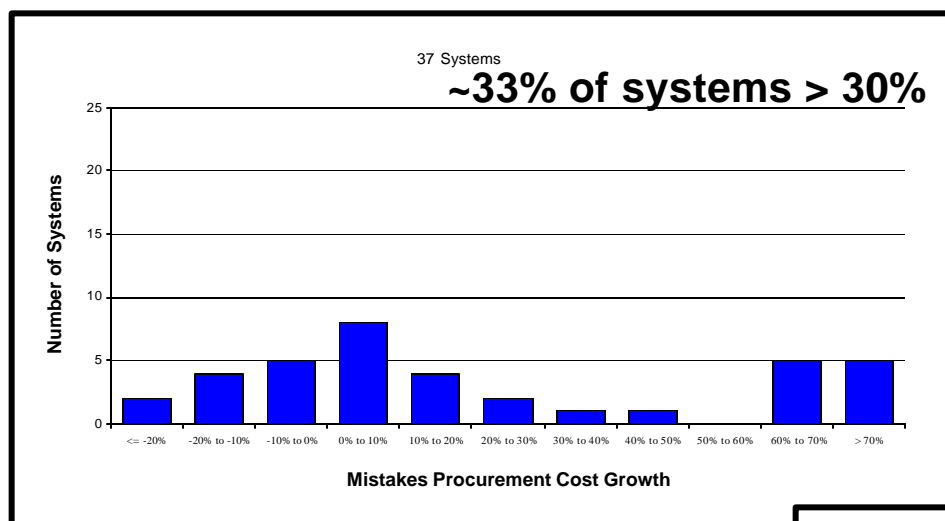
	Missile Programs	
	<u>Dual Source</u>	<u>Non Dual Source</u>
Number of Programs	6	19
Percent EMD Mistakes Cost Growth	7.4%	29.4%
Percent Procurement Mistakes Cost Growth	4.1%	15.2%

- **Dual Source Programs include:**

- AIM-9M
- AMRAAM
- HARM
- Hellfire
- Peacekeeper
- Tomahawk

# Cost Growth Histograms

Before 1980



After 1980

